INTEGRATE PROGRAM

Market Trends & Opportunities

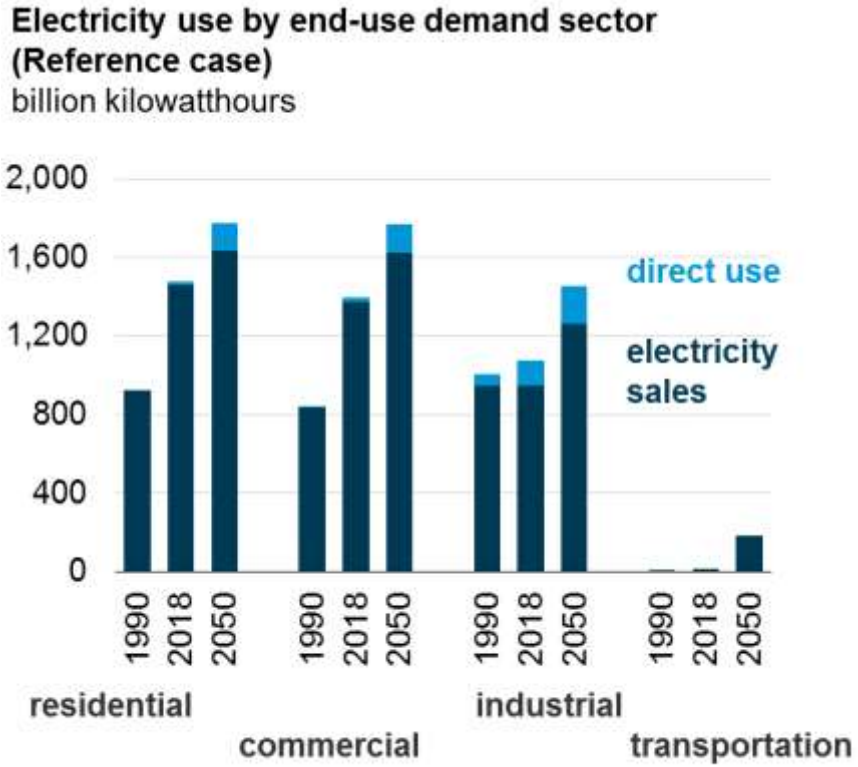
October 10, 2019

Outline

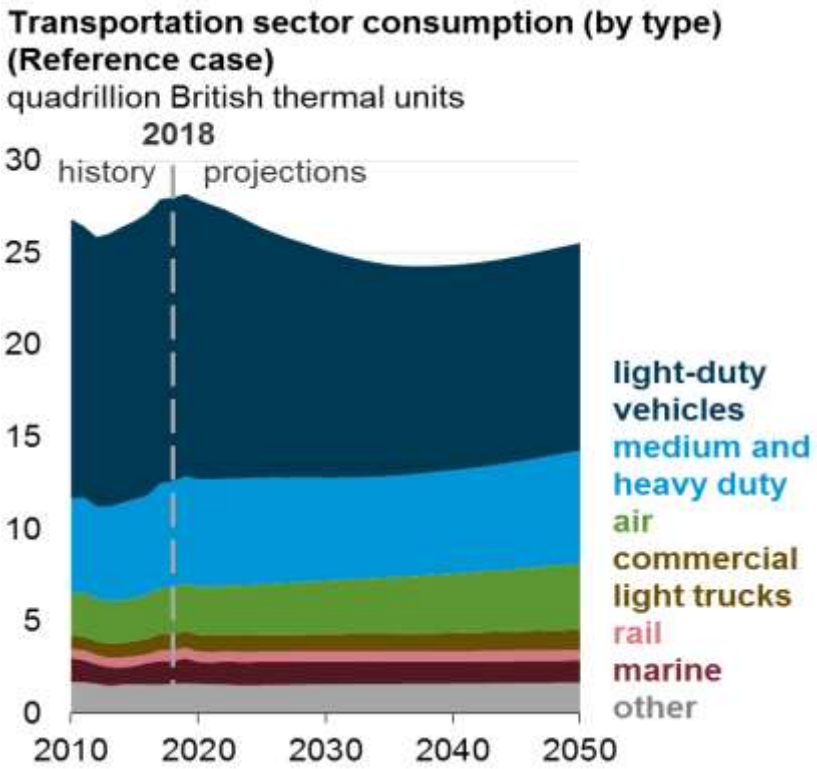
- Trends in Global Energy Markets
- Stationary Power
- Large Transport
- Business Model Canvas & Value Proposition
- Conclusions

US ENERGY DEMAND FORECASTS

Electric



Transportation

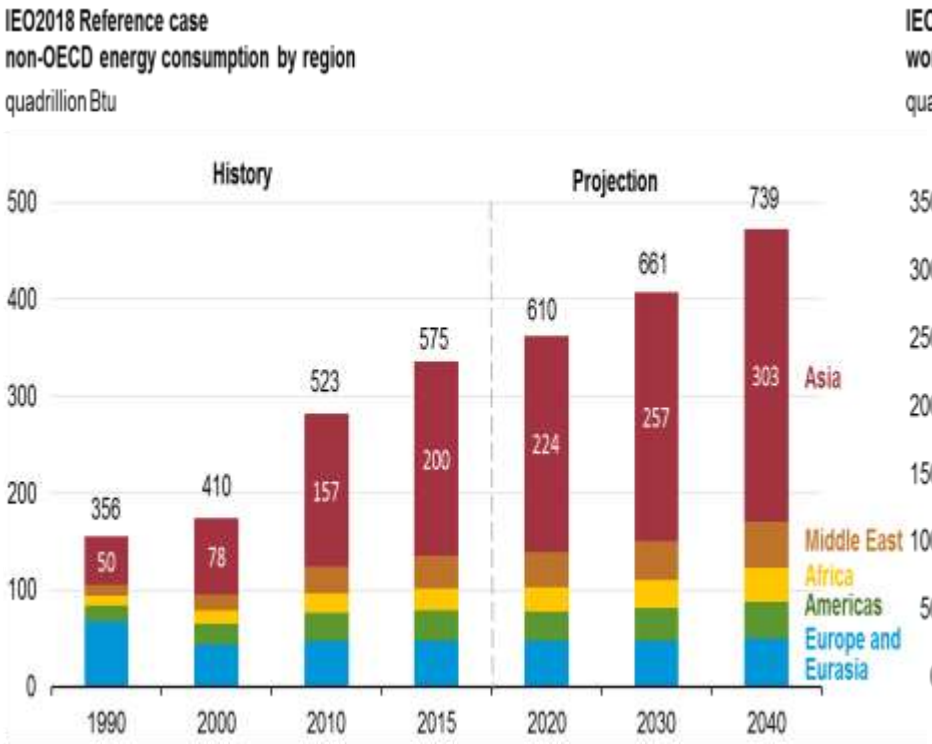


- *Continued modest growth in overall energy demand in the US*

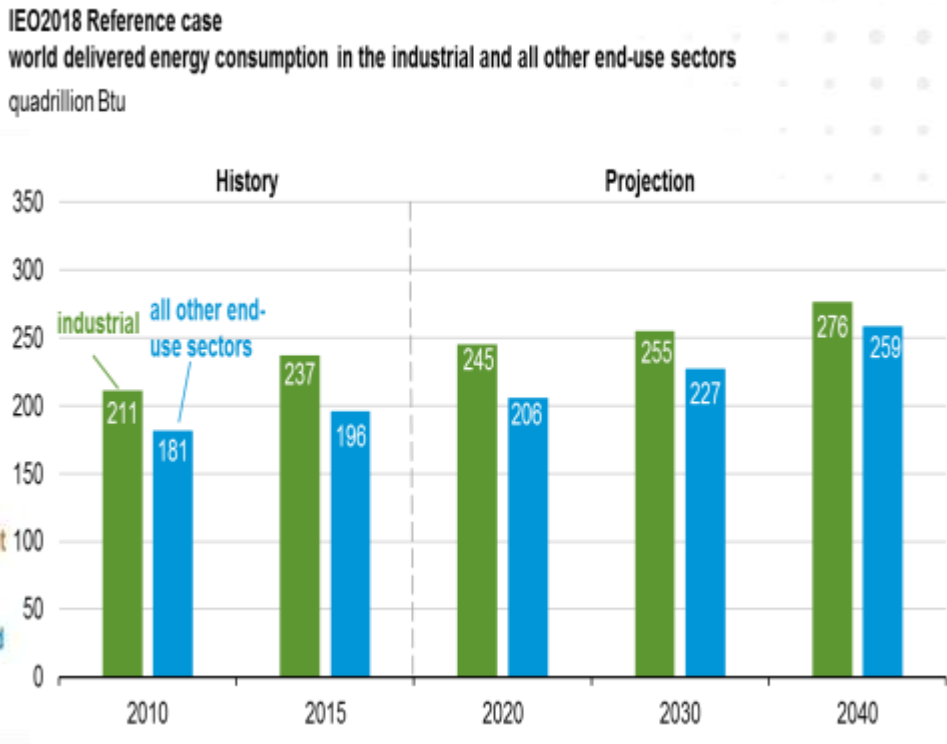
Source: US EIA Projections (2019)

INTERNATIONAL ENERGY DEMAND FORECASTS

Regional



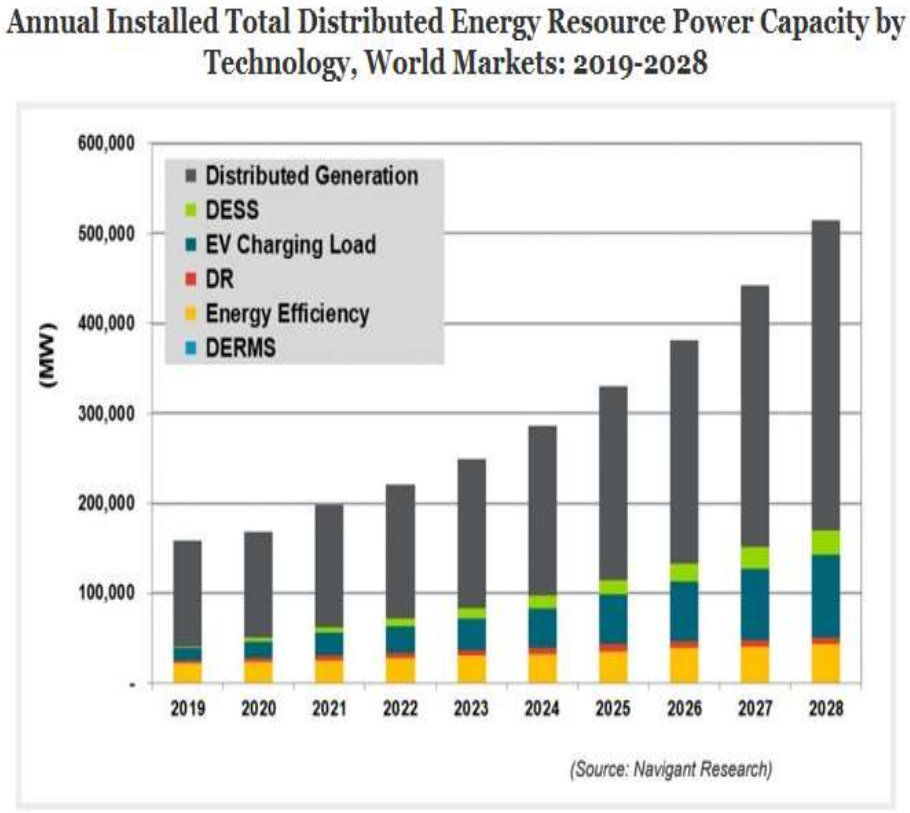
Sectoral

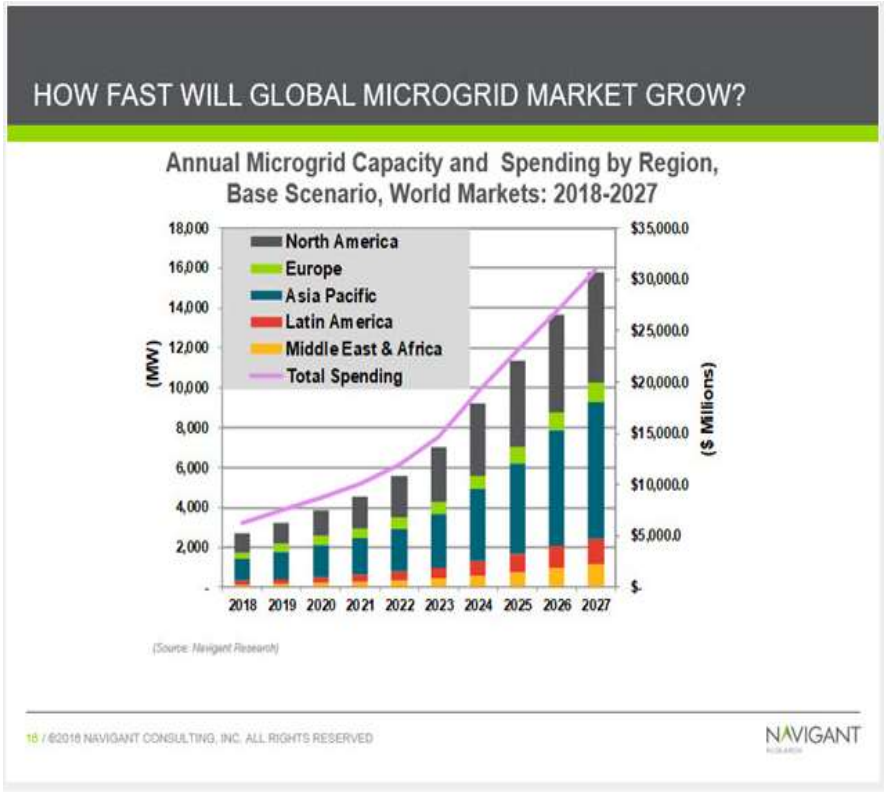


- *Significant growth forecasted for energy consumption globally driven by continued industrial growth in Asia*

Source: Global EIA Projections (2018)

STATIONARY POWER TRENDS





- Distributed generation should continue to grow (large share for solar)
- Globally forecasts suggest increased penetration of microgrids

Source: *Navigant*

STATIONARY POWER – NEW ENTRANTS

	EV charging	Energy management	Storage	PV	Demand response & VPP	Non-PV generation
Shell	• NewMotion • Greenlots • Ample Inc	• Sense Labs • Inspire • GridPoint	• Sonnen • Geli	• Sunseap • Clean Tech Solar • SolarNow	• MP2 Energy • Limejump • SteamaCo • Autogrid Systems	• Husk Power Systems
Total	• G2 Mobility • ChargePoint	• GreenFlex • Tendril Networks • Tado	• Sunverge • Stem	• SunPower • Zola Electric	• Autogrid Systems	• United Wind
bp	• Chargemaster • FreeWire • PowerShare	• Voltaware Services	• StoreDot	• Lightsource Renewables	• None	• None
Chevron	• ChargePoint	• None	• None	• None	• None	• None
ExxonMobil	• None	• None	• None	• None	• None	• None

Legend: In-house and M&A, Strategic investment, Partnership

- European oil and gas companies expanding into distributed energy resources businesses

Source: *Bloomberg NEF*

STATIONARY POWER SEGMENTS

- Largest growing segment
- Existing customer base (backup power)

- Cost targets less challenging (diesel displacement)
- Utility not involved

- Cost challenges (need to compete with grid power)
- Utility adoption

- Smaller segment
- Remote sites not easy to access (higher costs)

LARGE TRANSPORT OUTLOOK

Global Transportation

Chart 9

Revenue growth (local currency)

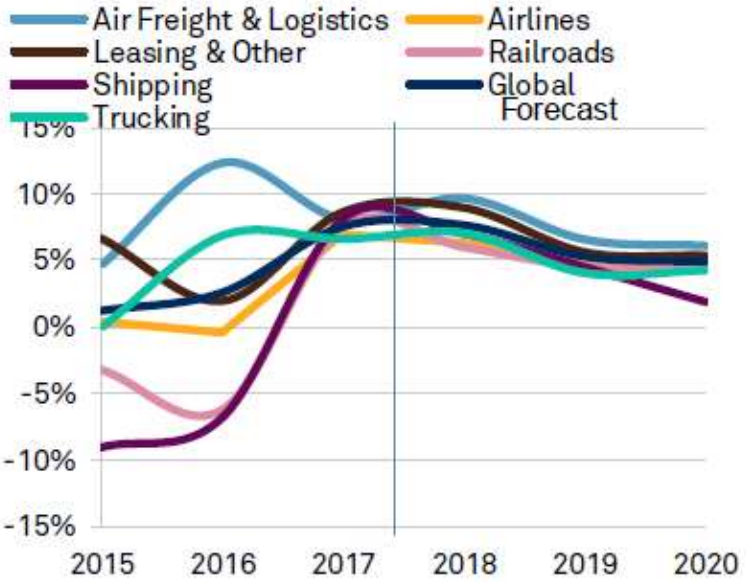
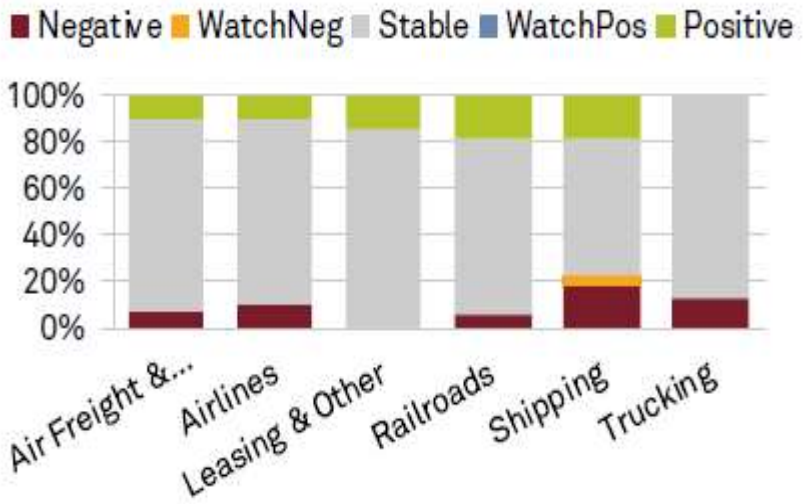


Chart 4

Ratings outlooks by subsector



Source: S&P Ratings

LARGE TRANSPORT SUBSECTOR TRENDS

Marine

- New sulfur standards by 2020 and potential targets for GHG in 2030 and beyond
- Slow and steady growth globally

Aviation

- Continued pressure for emissions reductions
- Growing interest in electrification (short haul early entry)
- Global growth story

Rail

- Passenger rail electrification common
- Freight rail electrification challenging (10s MW)
- Asian markets will continue to grow

LARGE TRANSPORT INNOVATION TRENDS

- Could systems proposed under the INTEGRATE program be the "bridging" solution?

MARINE POWER PLAYERS

Environmental performance of top ten shipping companies

Shipping company	CO2 emissions	Sulfur emissions	Ship-to-shore power connection?	Meets IMO's Ballast Water Convention (deadline 2021)?	Ship recycling – (Hong Kong Convention)?
MAERSK	Has target	Has initiatives	Retrofit ongoing	Compliant	Compliant
Mediterranean Shipping Company	Has initiatives	Has initiatives	Retrofit ongoing	Compliant	No activity
COSCO	Has initiatives	Has initiatives	No activity	Compliant	Compliant
CMA CGM	Has target	Has initiatives	Retrofit ongoing	Compliant	Compliant
Hapag-Lloyd	Has target	Has initiatives	Retrofit ongoing	Compliant	Compliant
Ocean Network Express	Has initiatives	No activity	No activity	Efforts underway	No activity
EVERGREEN	Has initiatives	Has initiatives	New ships fitted	Efforts underway	No activity
YANG MING	Has initiatives	Has initiatives	No activity	Efforts underway	Compliant
Pacific International Lines	Has initiatives	No activity	Retrofit ongoing	Efforts underway	No activity
HMM	Has target	Has initiatives	Retrofit ongoing	Compliant	Compliant

Source: BloombergNEF. Note: For details, see appendix 1. Top 10 international container shipping companies by TEU capacity. 1 TEU = the equivalent of a container 20 feet long and 8 feet wide; Gray = no progress; Light blue = some progress; Blue = good progress.

- Sulfur and eventually GHG standards will require new propulsion solutions

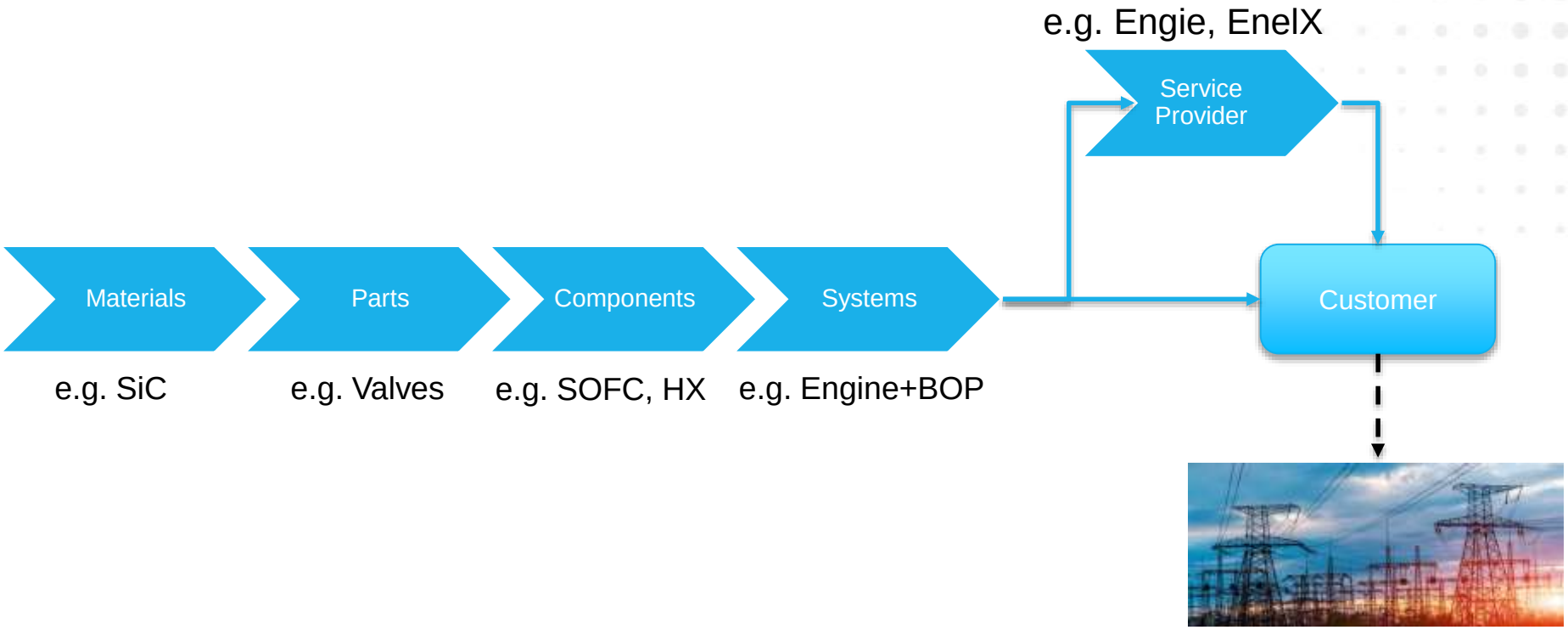
Source: BNEF

AVIATION PLAYERS

World's Largest Airlines By Fleet Size

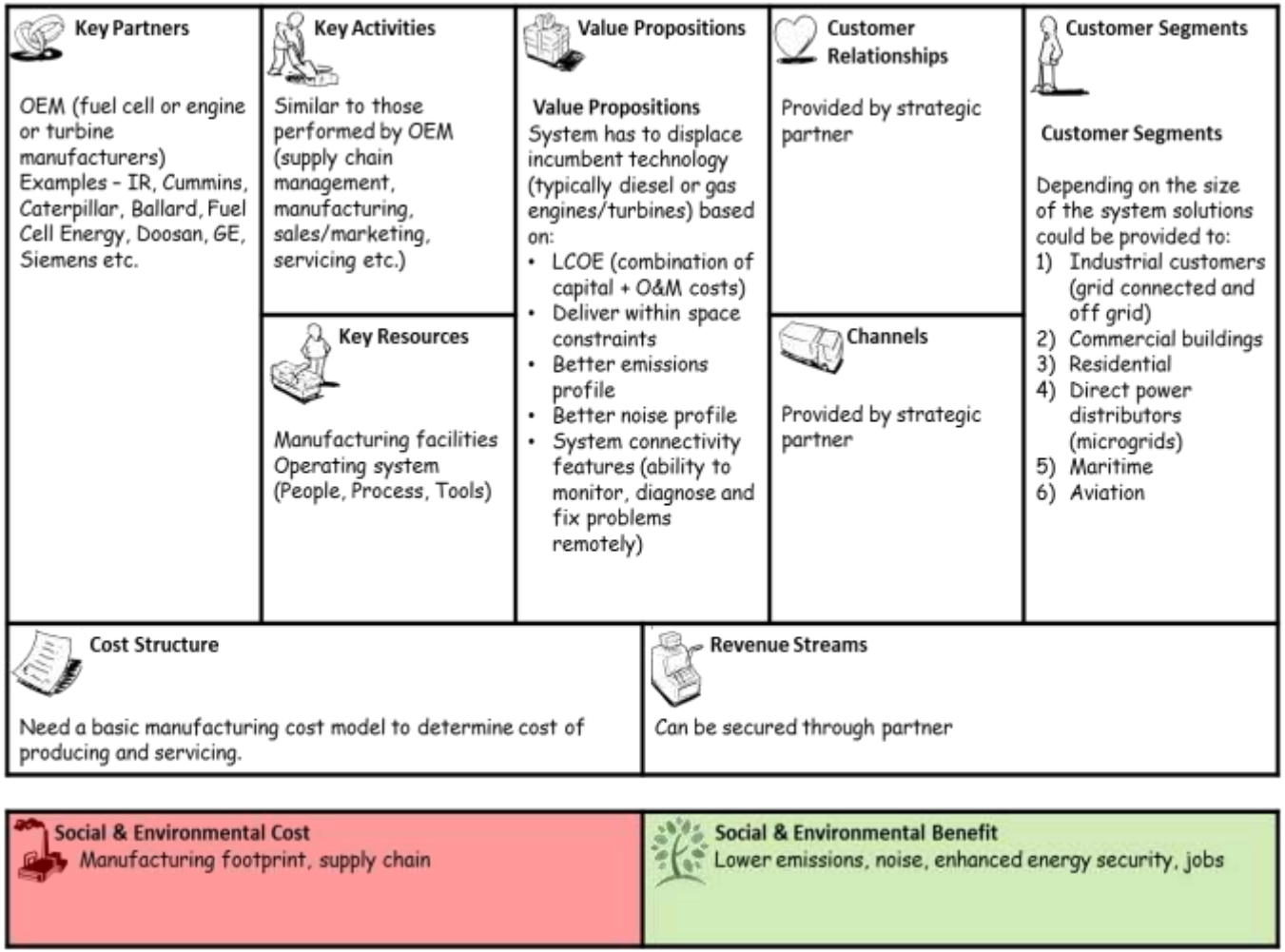
Rank	Airline	Country	Fleet (June 2016)
1	American Airlines	United States	1,789
2	Delta Air Lines	United States	1,330
3	United Airlines	United States	1,229
4	Southwest Airlines	United States	720
5	FedEx Express	United States	688
6	China Southern Airlines	China	515
7	China Eastern Airlines	China	429
8	Air Canada	Canada	404
9	Air China	China	384
10	Ryanair	Ireland	349

VALUE CHAIN



- Grid connected system will likely require going through a service provider for some companies
- Off grid and transportation sector systems may need to work with a “system solution provider” to get to end customer, e.g. Halliburton, Maersk, Boeing
- Further down the value chain, the more compressed the margin unless product offers a significant benefit and is not easily replicable
- Supply chain issues (novel materials, tooling etc.), needed for unique components can also prove challenging for economics

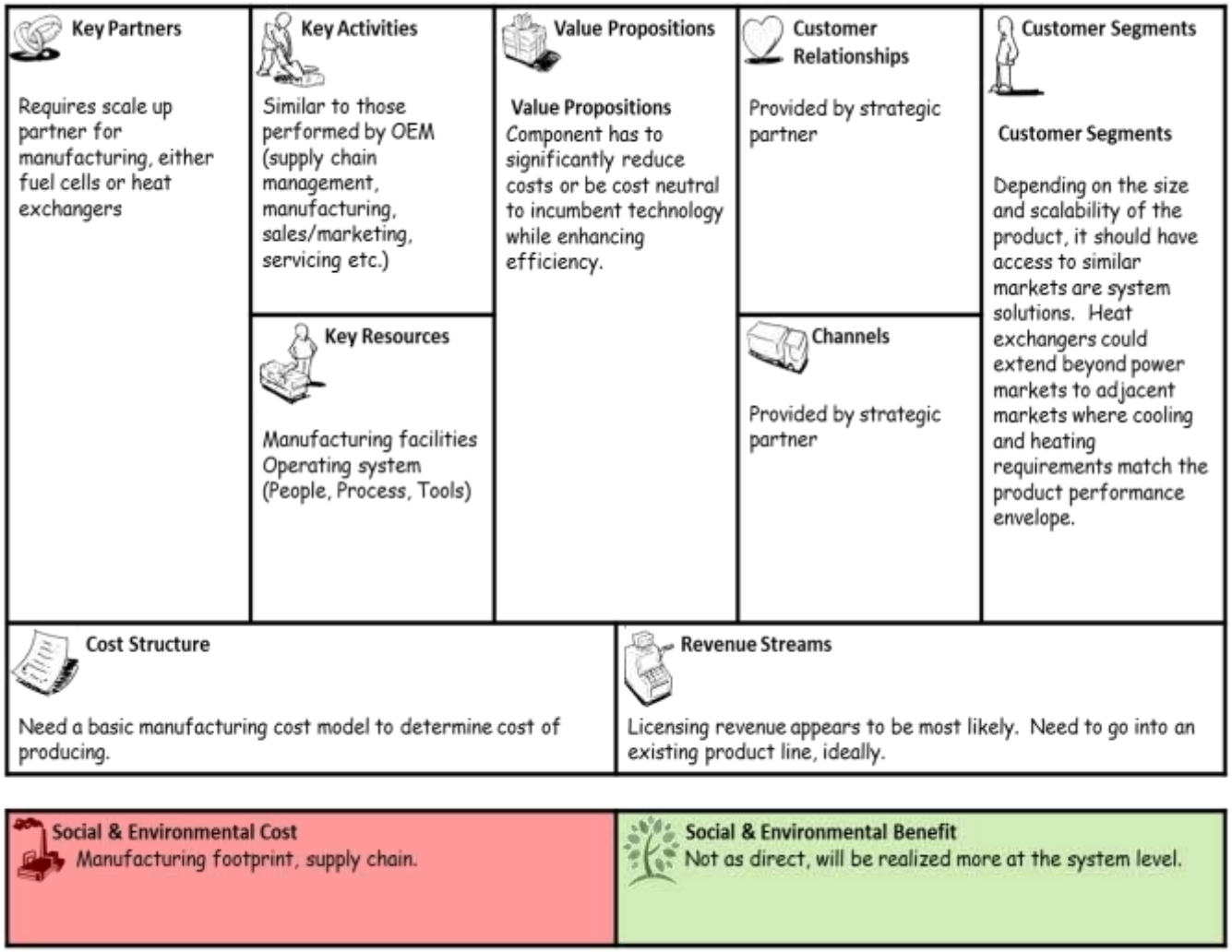
SYSTEM BUSINESS MODEL CANVAS



Hypotheses:

- Working with a strong commercialization partner is essential because this an OEM play
- Depending upon size and scalability, multiple segments could be served
- Value proposition will be driven by LCOE
- Certain segments could pay for additional features such as reduced emission, noise etc.
- Ability to remotely monitor systems is becoming increasingly important
- Manufacturing cost model will be required in Stage 2 and beyond to “sell” concept to next stage funders

COMPONENT BUSINESS MODEL CANVAS



Key Hypotheses:

- Existing manufacturers could launch component improvements as the next generation of products
- Since components are part of the CAPEX and O&M (non fuel) cost structures, need them to improve efficiencies while remaining cost neutral (if not lower)
- Component manufacturers have greater flexibility in terms of products reaching multiple, related markets (but more competition)
- Licensing revenue a more likely path for university or lab demonstrations/pilots

TEA ASSUMPTIONS

Table 2. Cost and performance characteristics of new central station electricity generating technologies

Technology	First available year[1]	Size (MW)	Lead time (years)	Base overnight cost (2018 $/kW)	Project contin-gency factor[2]	Techno-logical optimism factor[3]	Total overnight cost[4,10] (2018 $/kW)	Variable O&M[5] (2018 $/MWh)	Fixed O&M (2018$/ kW/yr)	Heat rate[6] (Btu/kWh)	Final heat rate (Btu/kWh)
Coal with 30% carbon sequestration (CCS)	2022	650	4	4,713	1.07	1.03	5,169	7.31	72.12	9,750	9,221
Coal with 90% CCS	2022	650	4	5,212	1.07	1.03	5,716	9.89	83.75	11,650	9,257
Conv gas/oil combined cycle (CC)	2021	702	3	952	1.05	1.00	999	3.61	11.33	6,600	6,350
Adv gas/oil CC	2021	1,100	3	736	1.08	1.00	794	2.06	10.30	6,300	6,200
Adv CC with CCS	2021	340	3	1,963	1.08	1.04	2,205	7.34	34.43	7,525	7,493
Internal combustion engine	2020	85	2	1,306	1.05	1.00	1,371	6.03	7.11	8,500	8,160
Conv combustion turbine[7]	2020	100	2	1,072	1.05	1.00	1,126	3.61	18.03	9,840	9,600
Adv combustion turbine	2020	237	2	658	1.05	1.00	691	11.02	7.01	9,800	8,550
Fuel cells	2021	10	3	6,250	1.05	1.10	7,197	46.56	0.00	9,500	6,960
Adv nuclear	2022	2,234	6	5,224	1.10	1.05	6,034	2.37	103.31	10,461	10,461
Distributed generation – base	2021	2	3	1,501	1.05	1.00	1,576	8.40	18.90	8,958	8,900
Distributed generation – peak	2020	1	2	1,804	1.05	1.00	1,894	8.40	18.90	9,948	9,880
Battery storage	2019	30	1	1,857	1.05	1.00	1,950	7.26	36.32	NA	NA
Biomass	2022	50	4	3,642	1.07	1.00	3,900	5.70	114.39	13,500	13,500
Geothermal[8,9]	2022	50	4	2,654	1.05	1.00	2,787	0.00	122.28	NA	NA
MSW - landfill gas	2021	50	3	8,313	1.07	1.00	8,895	9.47	425.38	18,000	18,000
Conventional hydropower[9]	2022	500	4	2,680	1.10	1.00	2,948	1.36	40.85	NA	NA
Wind[10]	2021	100	3	1,518	1.07	1.00	1,624	0.00	48.42	NA	NA
Wind offshore[8]	2022	400	4	4,758	1.10	1.25	6,542	0.00	80.14	NA	NA
Solar thermal[8]	2021	100	3	4,011	1.07	1.00	4,291	0.00	72.84	NA	NA
Solar PV - tracking[8, 10, 11]	2020	150	2	1,876	1.05	1.00	1,969	0.00	22.46	NA	NA
Solar PV – fixed tilt[8,10,11]	2020	150	2	1,698	1.05	1.00	1,783	0.00	22.46	NA	NA

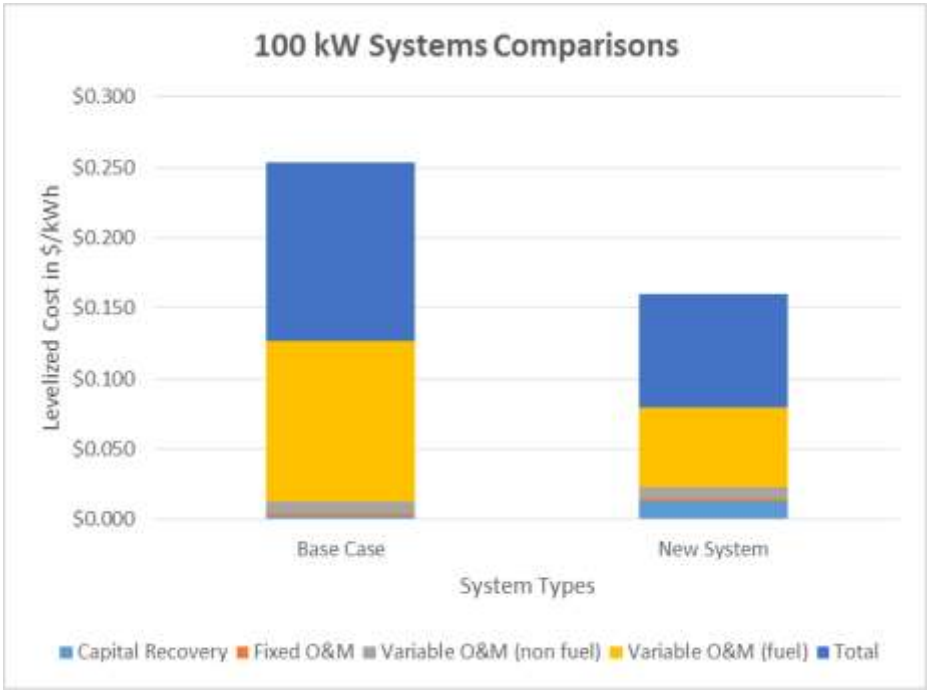
[1] Represents the first year that a new unit could become operational.

[2] AACE International (the Association for the Advancement of Cost Engineering) has defined contingency as, "An amount added to an estimate to allow for items, conditions, or events for which the state, occurrence, or effect is uncertain and that experience shows will likely result, in aggregate, in additional costs."

[3] The technological optimism factor is applied to the first four units of a new, unproven design; it reflects the demonstrated tendency to underestimate actual costs for a first-of-a-kind unit.

[4] Overnight capital cost includes contingency factors and excludes regional multipliers (except as noted for wind and solar PV) and learning effects. Interest charges are also excluded. The capital costs represent current costs for plants that would come online in 2019.

VALUE PROPOSITION (II)



Notes

- CAPEX base ~$400/kW and new system ~$2000/kW
- Efficiency base ~35% and new system ~70%
- Diesel fuel, $1.5/gallon
- Fixed O&M and variable O&M (non fuel identical)
- No cost of capital or financing assumptions made

How to win with new tech

- CAPEX will be an initial disadvantage but economies of scale can deliver improvements (need scale up partner)
- Minimize variable O&M (fuel), by enhancing efficiencies, eliminating more expensive and dirtier alternatives
- Minimize fixed O&M, reduce labor, implement digital solutions
- Minimize variable O&M (non fuel), by minimizing parts, miscellaneous materials (e.g. water), implement digital solutions
- Robust cost modeling (using aPriori, DFMA2019, PLM etc.)

CONCLUSIONS

- Global energy demand trends indicate potentially large emerging markets in Asia for systems developed under the INTEGRATE program
- Channel to market for systems in stationary power markets could be through micro-grid solution providers
- Applicability of systems proposed under the program for maritime applications requires further exploration
- Business models will impact the type of TEA that must be conducted to assess product value proposition